

Freeze –Thaw/Evaporation for Water Purification

Clean Water for Our Future



University of North Dakota
Grand Forks, North Dakota

A Natural Process

Natural freezing can be harnessed by FTE®.

Freeze-thaw/evaporation (FTE®) provides the opportunity for cost-effective treatment of brackish or contaminated water. Bench-scale testing of FTE® technology has proven it to be generally applicable to the treatment of ground and surface water, food-processing wastewater, and oil and gas industry produced waters.

FTE® offers these advantages:

- Quality water for agricultural, industrial, and municipal purposes
- Significant reductions in wastewater volume
- Required refrigeration provided at no cost
- No new wastes produced by the process



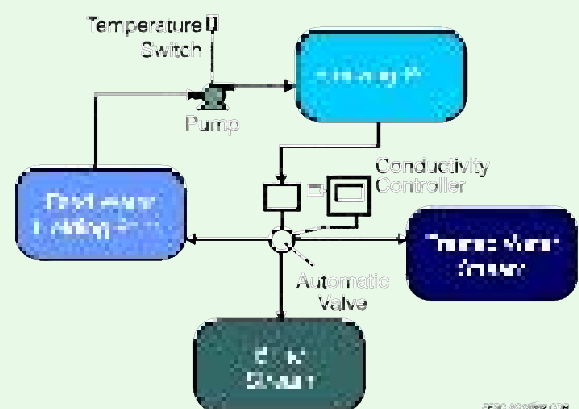
The Technology

When the ambient air temperature is below 32°F, the saline or contaminated water (feed water) is sprayed or dripped onto a freezing pad to create an ice pile. During subfreezing conditions, runoff from the ice pile will have elevated concentrations of chemical constituents compared to the feed water. This runoff can be diverted to a brine storage facility or back to the feed water storage facility for recycle. When temperatures promote melting or thawing, the runoff from the freezing pad will be highly purified water that can be diverted to a treated water storage facility for later beneficial uses or surface discharge. No new wastes are generated by the FTE® process.

Personnel from the Energy & Environmental Research Center (EERC) and B.C. Technologies, Ltd. (BCT), began development of several freeze-thaw water purification processes in 1992. Laboratory-, bench-, and field-scale test research has been funded by the following sponsors:

- U.S. Department of Energy
- Gas Research Institute
- Amoco Production Company
- City of Grand Forks, North Dakota
- U.S. Department of Agriculture
- U.S. Bureau of Reclamation
- North Dakota State Health Department
- McMurry Oil Company
- A consortium made up of food-processing and agriculture-related plants in the North Dakota and Minnesota area
- City of Devils Lake, North Dakota
- North Dakota Division of Community Services
- North Dakota Department of Health
- North Central Planning Council

The field-scale FTE® testing that was started in 1995 has received national recognition for its treatment of coalbed methane produced water.



The Freeze–Thaw/Evaporation (FTE®) Process

A promising new application of the natural freeze–thaw process is FTE®.

FTE® couples conventional evaporation and freeze–thaw for treatment and disposal of wastewater. During warm months, the FTE® system is operated as a conventional evaporation facility. However, during months with subfreezing (<32°F) temperatures, a large ice pile is created by spraying the water to be treated in a shallow pit, and the natural freeze–thaw process takes over. The FTE® process has been successfully applied to oil and gas produced waters. FTE® has the potential to enhance the economic and environmental viability of oil and gas production by providing water for beneficial use and obtaining a substantial reduction in wastewater volume.

Meeting a Need

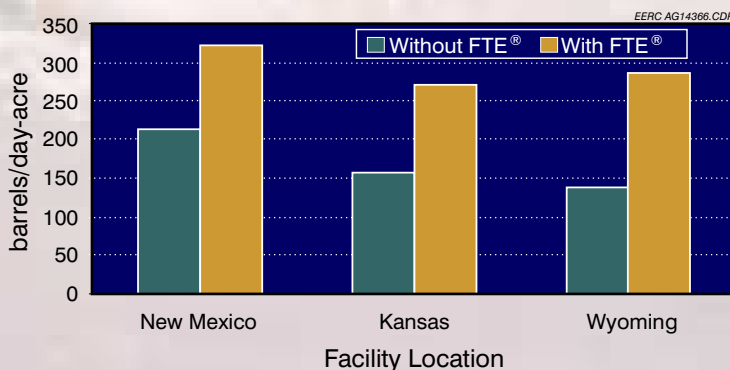
In every part of the world, water issues are more important than ever. Water supply and quality limit economic growth. FTE® supports sustainable growth by:

- Treatment of oil and gas produced water.
- Reducing industrial wastewater volume.
- Purifying waters for reuse or disposal from other industrial processes such as food processing.
- Desalinizing natural water supplies for agricultural, municipal, and industrial use.

This simple, cost-effective technology can be used worldwide wherever natural weather patterns permit.

FTE® Is Cost-Effective

Natural seasonal cycles are combined with inexpensive control equipment to automatically separate the process streams, offering industrial users reduced process water costs and reduced wastewater disposal costs.



- Throughput for each facility is computed to barrels of produced water processed per day-acre, where a day-acre represents 24 hours of evaporation on an acre of evaporative surface area.
- Operating a conventional evaporation facility as an FTE® facility allows productive operation of the facility during winter months when evaporation is minimal.
- Additional costs to modify an evaporation facility for FTE® are minimal.

FTE® Is Ready for Commercialization

Field test results confirm both the process's economic viability and its potential to reduce wastewater volume and produce a usable, quality treated water.

Over 20 freeze-thaw bench-scale simulations have been done using oil and gas industry produced waters, food-processing plant wastewaters, other industrial wastewaters, or naturally occurring brackish waters. In all cases, the freeze-thaw process technology proved to be technically feasible as a water treatment process.

Operation of a commercial-scale FTE® field test began in 1995 to evaluate its technical and economic feasibility for treating coalbed methane produced water. Based on the results of 2 years of field testing, Amoco Production Company is currently in the process of permitting a commercial facility in the San Juan Basin of New Mexico. The results of the Amoco field test confirm both the process's economic viability by reduction of produced water volumes and its potential to produce a usable, quality treated water from wastewaters arising from oil and natural gas production or other industrial sources by significant and simultaneous removal of salts, organics, and heavy metals. In 1997, McMurtry Oil Company began field deployment of the FTE® process in the Jonah field of Wyoming.



For Further Information

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The FTE® process also offers opportunities to enhance water supplies for industrial and municipal uses. During the summer of 1996, an evaluation of the natural freeze-thaw process for the desalinization of groundwater was conducted by the EERC in conjunction with BCT. The results confirmed the ability of the process to provide treated water of a quality suitable for municipal and industrial water supplies from saline aquifers or other saline water sources. During 1998 and 1999, the EERC and BCT constructed and operated an FTE® demonstration facility near Devils Lake, North Dakota. This project demonstrate the feasibility of FTE® as a reliable alternated source of municipal water for the city of Devils Lake. Under suitable climatic conditions, FTE® can be the solution to water supply and wastewater cleanup issues.